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THE ALTERNATE CURRENT TRANSFORMER.

The Alternate Current Transformer in Theory and Practice. By J. A. Fleming, M.A., D.Sc. Vol. I. "The Induction of Electric Currents." Pp. 479. (London: The *Electrician* Printing and Publishing Company, Limited, 1889.)

THE alternating current has of late years sprung into great commercial importance, and accordingly the laws regulating its flow, long known to a few, are becoming recognized and assimilated by the many. The behaviour of alternating currents is so vastly more complex than anything which had to be dealt with in the time-honoured chapter of the text-book concerning "divided circuits" for the case of steady currents, that a new literature has arisen, and a number of half-accepted new terms have been coined.

It is evidently with the aim of making accessible to average readers the greater portion of this subject that Dr. Fleming has put together the above-named book.

The volume is distinctly a compilation, a *réchauffée* of recent work, though it consists partly of a reprint of the author's own articles in the *Electrician*, and it is a compilation of a very useful kind. It brings together a quantity of floating information collected with a keen scent for practically useful items, as well as for topics of contemporary interest.

It is hardly a book to be recommended to the student as a logical treatise. The proof of the laws is a secondary consideration, and though proofs are indicated, it is more to link them on to other things than really to justify and deduce them. In fact the book has the air of being hastily written; but the facts are there, whether deduced rigorously or not, and the practical man, for whom it is written, will not be likely to find fault. In several instances, however, it can be claimed that the presentation of doctrines is as clear as could be wished and as the ability of the author would lead us to expect. Students will undoubtedly be glad of a book which contains so much useful information only accessible otherwise with difficulty.

The early part of the book, dealing with the modern treatment of magnetism, hysteresis, and the like, is fairly good, but is probably now superseded by some still more recent articles by Prof. Ewing himself. The next portion, on simply periodic currents, is very instructive. In it Lord Rayleigh's investigation of the laws of branching for alternating currents is incorporated, and the result applied to determine the correcting factor for a watt-meter; a clear explanation being given of why it is so difficult to measure the average power of an alternating current. Some of Mr. Blakesley's geometrical representations are also utilized; and the whole circumstances of a simply alternating current are very clearly explained.

Then comes an abstract of some of the too-long-buried researches of Prof. Henry, which the recent publication of his memoirs by the Smithsonian Institution has brought into prominence.

A brief account of the experimental investigations of Masson and Breguet, Blaserna, Helmholtz, on transient currents, of Hughes on the induction balance and on the throttling effect of iron wire, follows; together with the Maxwell-Rayleigh-Heaviside theory of the same.

We then come to the main subject of the book—the laws of mutual induction and the theory of induction coils or transformers. Here the author enters into very instructive detail, showing how to deal with transformers containing iron, and incorporating the researches of Hopkinson, Forbes, Sumpner, Ferraris, and Kapp, as well as the general theories of Maxwell and Lord Rayleigh.

A chapter headed "The Dynamical Theory of Current Induction" follows, wherein Prof. Garnett's summary of Maxwell's electro-magnetic ether models is reproduced; some instructive explanations of many Maxwellian ideas is given in a much clearer and more elementary form than is frequent; some experiments and articles of the present writer are incorporated; and lastly, Mr. Tunzelmann's abstract of Hertz's papers is reprinted once more. It is to be regretted that we have not the advantage of a fresh abstract and discussion of these papers by Dr. Fleming himself. So much in Hertz's papers was confessedly crude and tentative that it would have been much more satisfactory to have had a real digest from a contemporary point of view, instead of the useful but now out-of-date summary with which most persons were already familiar.

Perhaps also it may without offence be suggested that a free use of quotation marks in this last chapter, possibly in other chapters also, would not have been out of place. One is a little startled to find whole paragraphs and diagrams incorporated into a book without rather more explicit statement concerning their origin. I may instance pp. 380, 408, 409, among others, as having struck me personally with some surprise, though very likely the feeling was unjustifiable.

It may be useful if I record such trifling slips as I have noticed. Quite possibly some are not erroneous at all. On p. 7 the assertion is made that Faraday "came to see that that which he had denominated the *electrotonic state* is really the amount of electro-magnetic momentum which the circuit possesses." As a matter of history this is surely incorrect? And is there any evidence for the statement on p. 2, that Faraday's failure to obtain current induction in 1825 and 1828 was because his galvanometer circuit was not closed? It seems very improbable. At the bottom of p. 67 the argument seems to me incorrect and confusing. In the diagram on p. 140 *current* should appear as a factor in the lengths OB, BA, &c. On the top of p. 145, there is no need for L and N to be *both* zero in order that the wattmeter factor, F, may equal unity; it is sufficient if the time constant of the fine wire shunt alone vanishes. On p. 209 a p is twice dropped out of an equation. On p. 253 the statement is made "that we may regard the inductance of a conductor as an effect which is due to the fact that the current takes time to penetrate into the conductor"—a statement which is by no means true. And two pages on we read, "as the frequency of alternation is increased, the resultant self-induction of the circuit is lessened, but [? so that] although the true resistance is increased, the impedance may be diminished on the whole." It may, however, be more truly asserted that no

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increase in frequency can diminish impedance: it always tends to increase it; and in no case can the impedance of a conductor to alternating currents fall below that felt by steady ones. Both resistance and impedance increase with frequency. It is true that inductance diminishes, but the diminution is very slight except for iron rods. The punctuation of p. 353 has gone somewhat astray.

All these are trifles: the average level of the book is high, and it contains few dull pages. The practical importance and interest of the subject treated is so great that there should be little need to urge students and electrical engineers to make themselves acquainted with it, but I do urge them nevertheless; and they may think it fortunate that Dr. Fleming has managed to find time to issue so instructive and readable and well-timed a volume.

OLIVER J. LODGE.

McKENDRICK'S "SPECIAL PHYSIOLOGY."

Special Physiology, including Nutrition, Innervation, and Reproduction. Vol. II. By J. G. McKendrick, M.D., LL.D., F.R.S. (Glasgow: Maclehose and Sons. London: Macmillan and Co. 1889.)

IN the first volume the only purely physiological part was that on muscle, leaving all the rest of the science to be treated of in this volume, which thus includes the physiology of digestion, nutrition, blood and circulation, respiration and the nervous system, as well as reproduction. It is evident that the book must either be of an entirely elementary character, or that the treatment must in parts be extremely inadequate, in order to include all these subjects within the dimensions of a moderate-sized volume. As a matter of fact, it lies open to both these objections. In some places the author hampers himself in the treatment of the purely physiological part of the subject by expounding the first elements of chemistry and physics (for the benefit, I suppose, of the average Glasgow student); while other parts, though good, are much too condensed to be understood by the reader who is ignorant of the first principles of science. This disproportion in the treatment of the various subjects meets us at the very beginning of the volume, where twenty pages are devoted to dietetics before any description has been given of the processes of digestion.

In the section on digestion a very good condensed account is given of the theory of secretion. One is surprised, however, to meet with the statement that the submaxillary ganglion can act as a reflex centre. The importance of this view for the physiology of sporadic ganglia is enormous; yet Prof. McKendrick is content with describing Claude Bernard's old experiments, which seemed to support it, and makes no mention of the researches of Bidder and Schiff, made so long ago as 1867, which showed that the secretion obtained in Bernard's experiments was due to recurrent fibres of the chorda tympani, and not to any action of the ganglion as a reflex centre.

The account of the action of the bile on the chyme is not quite accurate. He says: "At the same time the taurocholate of soda throws down the non-peptonized albuminous matters, such as coagulable albumin and syntonin, while the hemialbumose and peptones remain in solution." As a matter of fact, the precipitate consists of parapeptone (syntonin) with a small quantity of peptones.

In describing the formed elements of the blood, no mention is made of the plasma or granule cells. Yet these are daily assuming a larger importance in pathological processes, and every student who is to study medicine should at any rate know of their existence.

In the section on coagulation as fair an account is given of Wooldridge's work on the subject as is possible in the limits of a page and a half; but in his summing up of the differences between this observer and Halliburton, he does not seem to have grasped Wooldridge's theory. He rejects this on the grounds that all Wooldridge's work was done with peptone plasma (which was not the case), and that fibrinogen (Hammarstens) contains no lecithin and can yet clot on addition of lecithin free ferment. That fibrinogen contains no lecithin is, to say the least, extremely doubtful. Bunge states that he has never succeeded in preparing any proteid free from phosphorus. It is practically impossible, however, to form a good judgment on the merits of Dr. Wooldridge's work without reading all his papers on the subject. In none of them has he discussed the question in all its details, and it is probably on this account that his work has been so misunderstood and misrepresented.

It is surprising how few books on physiology mention the *rôle* of the spleen (made so much of by Metschnikoff) as the great *blood-filter*, where all effete blood corpuscles and other deleterious materials are devoured and destroyed by the cells of the splenic pulp. In this volume the rhythmic movements of this organ are fully described, and a long list is given of the extractives that it contains, but its function is left entirely in doubt.

The next two sections, on the circulation and respiration, present the subject fairly completely, and are brief without being obscure. Yet these are not free from some misleading statements. Thus the depressor nerve is included among the afferent nerves that act on the inhibitory or accelerating cardiac centres, so that a student would imagine that stimulation of this nerve lowered the blood-pressure by reflex inhibition of the heart—a mistake one meets with only too often in teaching. Again, in describing the forces concerned in carrying on the circulation through the capillaries, he makes the following statement:—

> "Some have supposed that it is supplemented by an attractive influence exerted by the tissues (*vis a fronte*), and the statement is supported by the observation that, when there is an increased demand for blood owing to active nutritional changes, there is an increase in the amount of blood flowing to the part, such as occurs, for example, in the mammary gland during lactation, and in the growth of the stag's horn. Such an attractive influence on the part of the tissues is quite conceivable as a force assisting in the onward flow of blood, acting along with capillarity."

It is rather hard to see how an attractive influence on the part of the tissues can assist in the onward flow of blood, even when it *is* assisted by capillarity. At any rate this statement is sure to be devoured greedily by the studious fool, who will thereafter reproduce it on all possible occasions, probably as the chief factor in the circulation of the blood.

In discussing the nervous mechanism of respiration,

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